# HEDS-9710 / 9711

Motion Sensing Products
Optical Encoder Modules

## Reliability Data Sheet

### Description

The following cumulative test results have been obtained from testing performed at Avago Technologies in accordance with the latest revision of MIL-STD-883.

Avago tests parts at the absolute maximum rated conditions recommended for the device. The actual performance you obtain from Avago parts depends on the electrical and environmental characteristics of your application but will probably be better than the performance outlined in Table 1.

### Failure Rate Prediction

The failure rate of semiconductor devices is determined by the junction temperature of the device. The relationship between ambient temperature and actual junction temperature is given by the following:

$T_J$ (°C) = $T_A$ (°C) + $\theta_{JA}$ $P_{AVG}$

where $T_A$ = ambient temperature in °C

$\theta_{JA}$ = thermal resistance of junction-to-ambient in °C/watt

$P_{AVG}$ = average power dissipated in watts

The estimated MTBF and failure rate at temperatures lower than the actual stress temperature can be determined by using an Arrhenius model for temperature acceleration. Results of such calculations are shown in the table on the following page using an activation energy of 0.43 eV (reference MIL-HDBK-217).

**Table 1. Life Tests**
**Demonstrated Performance**

| | | | | | Point Typical Performance | |
|---|---|---|---|---|---|---|
| Test Name | Stress Test Conditions | Total Device Hrs. | Units Tested | Units Failed | MTBF | Failure Rate (% /1K Hours) |
| High Temperature Operating Life | $V_{CC}$ = 5.5 V<br>$V_A$ = $V_B$ = 3.5 V<br>$T_A$ = 100°C<br>1,000 hours | 77,000 | 77 | 0 | 77,000 | 1.3 |
| Temperature Humidity Operating Life | $V_{CC}$ = 5.5 V<br>$V_A$ = $V_B$ = 3.5 V<br>1,000 hours<br>$T_A$ = 85°C<br>RH = 85% | 77,000 | 77 | 0 | 77,000 | 1.3 |

**Table 2. Reliability Predictions**

| | | Point Typical Performance in Time [1] (60% Confidence) | | Performance in Time [2] (90% Confidence) | |
|---|---|---|---|---|---|
| Ambient Temperature (°C) | Junction Temperature (°C) | MTBF [1] | Failure Rate (%/1K Hours) | MTBF [2] | Failure Rate (%/1K Hours) |
| 100 | 110 | 77,000 | 1.299 | 33,000 | 2.990 |
| 90 | 100 | 109,000 | 0.916 | 47,000 | 2.109 |
| 80 | 90 | 158,000 | 0.634 | 69,000 | 1.459 |
| 70 | 80 | 233,000 | 0.429 | 101,000 | 0.988 |
| 60 | 70 | 352,000 | 0.284 | 153,000 | 0.654 |
| 50 | 60 | 545,000 | 0.184 | 237,000 | 0.423 |
| 40 | 50 | 866,000 | 0.115 | 376,000 | 0.266 |
| 30 | 40 | 1,419,000 | 0.070 | 616,000 | 0.162 |
| 20 | 30 | 2,401,000 | 0.042 | 1,043,000 | 0.096 |
| 10 | 20 | 4,212,000 | 0.024 | 1,829,000 | 0.055 |

Notes:

1. The point typical MTBF (which represents 60% confidence level) is the total device hours divided by the number of failures. In the case of zero failures, one failure is assumed for this calculation.
2. The 90% Confidence MTBF represents the minimum level of reliability performance which is expected from 90% of all samples. This confidence interval is based on the statistics of the distribution of failures. The assumed distribution of failures is exponential. This particular distribution is commonly used in describing useful life failures. Refer to MIL-STD-690B for details on this methodology.
3. Failures are catastrophic or parametric. Catastrophic failures are open, short, no logic output, no dynamic parameters while parametric failures are failures to meet an electrical characteristic as specified in product catalog such as output voltage, duty or state errors.

## Example of Failure Rate Calculation

Assume a device operating 8 hours/day, 5 days/week. The utilization factor, given 168 hours/week is:

(8 hours/day) x (5 days/week) / (168 hours/week) = 0.25

The point failure rate per year (8760 hours) at 50°C ambient temperature is:

(0.184% / 1K hours) x (0.25) x (8760 hours/year) = 0.403 % per year

Similarly, 90% confidence level failure rate per year at 50°C:

(0.423% / 1K hours) x (0.25) x (8760 hours/year) = 0.926 % per year

**Table 3. Environmental Tests**

| Test Name | MIL-STD-883 Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| Temperature Cycle | 1010 | -40°C to 100°C; 15 min. dwell; 5 min. transfer. | | |
| | | 20 cycles | 1638 | 0 |
| | | 200 cycles | 1638 | 0 |
| | | 500 cycles | 468 | 0 |
| Solder Heat Resistance | 2003 | Sn/Pb 60/40 Solder; 260°C peak 10 sec., 20 temp cycles @ -40°C to 85°C | 40 | 0 |
| High Temperature Storage Life | N/A | $T_A$ = +105°C 1000 hours | 77 | 0 |

**Table 4. Mechanical Tests**

| Test Name | MIL-STD-883 Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| Mechanical Shock | 2002 | 5 blows; X, Y, Z axes, 1500 g, 0.5 msec. | 5 | 0 |
| Vibration Variable Frequency | 2007 | 3 cycles, 4 min. each X, Y, Z axes, 20 g min | | |
| | | 20 to 2000 Hz | 26 | 0 |
| | | 5 to 1000 Hz | 10 | 0 |
| Terminal Strength | 2004 Cond. A | 1 lb. for 30 seconds | 15 | 0 |
| Lead Fatigue | 2004, Cond. B | 3 bends, 15° minimum | 15 | 0 |

**Table 5. Electrical Tests**

| Test Name | MIL-STD-883 Reference | Test Conditions | Units Tested | Units Failed |
|---|---|---|---|---|
| ESD - Human Body Model | 3015.2 | 1.5 K ohms, 100 pF, 5 positive and 5 negative discharges per pin. $V_Z$ = 3.0 KV | 12 | 0 |

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